

## WHAT IS CLAIMED IS:

1           1. For use in a single integrated circuit multi-  
2 standard demodulator, a frequency domain equalizer for  
3 demodulation of a single carrier signal comprising:

4           a signal multiplier producing an equalized output  
5 from a frequency domain input and a frequency domain  
6 inverse channel estimate; and

7           an adaptive inverse channel estimator calculating  
8 said frequency domain inverse channel estimate utilizing a  
9 least square cost function.

1           2. The frequency domain equalizer as set forth in  
2 Claim 1 wherein said adaptive inverse channel estimator  
3 calculates said frequency domain inverse channel estimate  
4 utilizing a diagonal correlation matrix.

1           3.    The frequency domain equalizer as set forth in  
2    Claim 2 wherein said adaptive inverse channel estimator  
3    employs a memory, a forgetting factor employed to calculate  
4    a current diagonal element within said correlation matrix  
5    from a previous diagonal element within said correlation  
6    matrix, and an adaptation and error control constant  
7    employed to alter a previous inverse channel estimate  
8    matrix element to derive a current inverse channel estimate  
9    matrix element, wherein values for said forgetting factor  
10   and said adaptation and error control constant are selected  
11   such that multiplication by either said forgetting factor  
12   or said adaptation and error control constant may be  
13   implemented by shift and add operations.

1           4.    The frequency domain equalizer as set forth in  
2    Claim 3 wherein said adaptive inverse channel estimator  
3    further comprises:

4                a complex conjugator receiving a delayed input  
5    signal;

6                a signal multiplier receiving both said delayed  
7    input signal and an output of said complex conjugator;

8                a signal adder receiving an output of said signal  
9    multiplier and said previous diagonal element within said  
10   correlation matrix multiplied by said forgetting factor, a  
11   output of said signal adder comprising said current  
12   diagonal element within said correlation matrix.

1           5. The frequency domain equalizer as set forth in  
2 Claim 4 wherein said adaptive inverse channel estimator  
3 further comprises:

4           a signal divider receiving said output of said  
5 complex conjugator and said output of said signal adder;

6           a second signal multiplier receiving an output of  
7 said signal divider and a frequency domain error estimate;  
8 and

9           a second signal adder receiving an output of said  
10 second signal multiplier multiplied by said adaptation and  
11 error control constant and said previous inverse channel  
12 estimate matrix element, an output of said second signal  
13 adder comprising said current inverse channel estimate  
14 matrix element.

1           6.    A   single   integrated   circuit   multi-standard  
2   demodulator comprising:

3               a first decoder selectively demodulating a multi-  
4   carrier signal; and

5               a second decoder selectively demodulating a  
6   single carrier signal, said second decoder including a  
7   frequency domain equalizer comprising:

8                   a signal multiplier producing an equalized  
9   output from a frequency domain input and a frequency  
10   domain inverse channel estimate; and

11                  an adaptive inverse channel estimator  
12   calculating said frequency domain inverse channel  
13   estimate utilizing a least square cost function.

1           7.    The demodulator as set forth in Claim 6 wherein  
2   said adaptive inverse channel estimator calculates said  
3   frequency domain inverse channel estimate utilizing a  
4   diagonal correlation matrix.

1           8.    The demodulator as set forth in Claim 7 wherein  
2    said adaptive inverse channel estimator employs a memory, a  
3    forgetting factor employed to calculate a current diagonal  
4    element within said correlation matrix from a previous  
5    diagonal element within said correlation matrix, and an  
6    adaptation and error control constant employed to alter a  
7    previous inverse channel estimate matrix element to derive  
8    a current inverse channel estimate matrix element, wherein  
9    values for said forgetting factor and said adaptation and  
10   error    control    constant    are    selected    such    that  
11   multiplication by either said forgetting factor or said  
12   adaptation and error control constant may be implemented by  
13   shift and add operations.

1           9.    The demodulator as set forth in Claim 8 wherein  
2    said adaptive inverse channel estimator further comprises:  
3           a complex conjugator receiving a delayed input  
4    signal;  
5           a signal multiplier receiving both said delayed  
6    input signal and an output of said complex conjugator;  
7           a signal adder receiving an output of said signal  
8    multiplier and said previous diagonal element within said  
9    correlation matrix multiplied by said forgetting factor, a  
10   output of said signal adder comprising said current  
11   diagonal element within said correlation matrix.

1           10. The demodulator as set forth in Claim 9 wherein  
2       said adaptive inverse channel estimator further comprises:

3           a signal divider receiving said output of said  
4       complex conjugator and said output of said signal adder;

5           a second signal multiplier receiving an output of  
6       said signal divider and a frequency domain error estimate;  
7       and

8           a second signal adder receiving an output of said  
9       second signal multiplier multiplied by said adaptation and  
10      error control constant and said previous inverse channel  
11      estimate matrix element, an output of said second signal  
12      adder comprising said current inverse channel estimate  
13      matrix element.



1           11. For use in a frequency domain equalizer, a method  
2 of adaptive inverse channel estimation comprising:

3                 multiplying a frequency domain input from a  
4 single carrier and a frequency domain inverse channel  
5 estimate to produce an equalized output; and

6                 calculating the frequency domain inverse channel  
7 estimate utilizing a least square cost function.

1           12. The method as set forth in Claim 11 wherein the  
2 step of calculating the frequency domain inverse channel  
3 estimate utilizing a least square cost function further  
4 comprises:

5                 calculating the frequency domain inverse channel  
6 estimate utilizing a diagonal correlation matrix.

1           13. The method as set forth in Claim 12 wherein the  
2       step of calculating the frequency domain inverse channel  
3       estimate utilizing a least square cost function further  
4       comprises:

5           storing a previous diagonal element within the  
6       correlation matrix and a previous inverse channel estimate  
7       matrix element within a memory;

8           employing a forgetting factor to calculate a  
9       current diagonal element within the correlation matrix from  
10      the previous diagonal element within the correlation  
11      matrix; and

12          employing an adaptation and error control  
13      constant to alter the previous inverse channel estimate  
14      matrix element and derive a current inverse channel  
15      estimate matrix element,

16          wherein values for the forgetting factor and the  
17      adaptation and error control constant are selected such  
18      that multiplication by either the forgetting factor or the  
19      adaptation and error control constant may be implemented by  
20      shift and add operations.

1           14. The method as set forth in Claim 13 wherein the  
2       step of calculating the frequency domain inverse channel  
3       estimate utilizing a least square cost function further  
4       comprises:

5                 computing a complex conjugate of a delayed input  
6       signal;

7                 multiplying the delayed input signal with the  
8       complex conjugate; and

9                 adding a result of multiplying the delayed input  
10      signal with the complex conjugate to the previous diagonal  
11      element within the correlation matrix multiplied by the  
12      forgetting factor to produce the current diagonal element  
13      within the correlation matrix.

1           15. The method as set forth in Claim 14 wherein the  
2 step of calculating the frequency domain inverse channel  
3 estimate utilizing a least square cost function further  
4 comprises:

5           dividing the complex conjugate by the current  
6 diagonal element within the correlation matrix;

7           multiplying a result of dividing the complex  
8 conjugate by the current diagonal element within the  
9 correlation matrix with a frequency domain error estimate  
10 and the adaptation and error control constant; and

11           adding the previous inverse channel estimate  
12 matrix element to a result of multiplying the result of  
13 dividing the complex conjugate by the current diagonal  
14 element within the correlation matrix with a frequency  
15 domain error estimate and the adaptation and error control  
16 constant to produce the current inverse channel estimate  
17 matrix element.

1           16. A single integrated circuit multi-standard  
2 demodulator comprising:

3           an OFDM decoder; and

4           a VSB decoder, said VSB decoder including a  
5 frequency domain equalizer comprising:

6           a signal multiplier producing an equalized  
7 output from a frequency domain input and a frequency  
8 domain inverse channel estimate; and

9           an adaptive inverse channel estimator  
10 calculating said frequency domain inverse channel  
11 estimate utilizing a least square cost function,  
12 wherein said frequency domain equalizer utilizes hardware  
13 employed for said OFDM decoder.

1           17. The demodulator as set forth in Claim 16 wherein  
2       said adaptive inverse channel estimator calculates said  
3       frequency domain inverse channel estimate utilizing:

4           a diagonal correlation matrix;

5           a forgetting factor in calculating a current  
6       diagonal element within said correlation matrix from a  
7       previous diagonal element within said correlation matrix;

8           an adaptation and error control constant in  
9       altering a previous inverse channel estimate matrix element  
10      to derive a current inverse channel estimate matrix  
11      element,

12           wherein values for said forgetting factor and  
13      said adaptation and error control constant are selected  
14      such that multiplication by either said forgetting factor  
15      or said adaptation and error control constant may be  
16      implemented by shift and add operations within said  
17      hardware employed for said OFDM decoder.

1           18. The demodulator as set forth in Claim 17 wherein  
2       said adaptive inverse channel estimator employs a memory  
3       within said hardware employed for said OFDM decoder to  
4       store said previous diagonal element for said correlation  
5       matrix and said previous inverse channel estimate matrix  
6       element.

1           19. The demodulator as set forth in Claim 18 wherein  
2       said adaptive inverse channel estimator further comprises:

3           a complex conjugator receiving a delayed input  
4       signal;

5           a signal multiplier receiving both said delayed  
6       input signal and an output of said complex conjugator;

7           a signal adder receiving an output of said signal  
8       multiplier and said previous diagonal element within said  
9       correlation matrix multiplied by said forgetting factor, a  
10      output of said signal adder comprising said current  
11      diagonal element within said correlation matrix.



1           20. The demodulator as set forth in Claim 19 wherein  
2       said adaptive inverse channel estimator further comprises:

3           a signal divider receiving said output of said  
4       complex conjugator and said output of said signal adder;

5           a second signal multiplier receiving an output of  
6       said signal divider and a frequency domain error estimate;  
7       and

8           a second signal adder receiving an output of said  
9       second signal multiplier multiplied by said adaptation and  
10      error control constant and said previous inverse channel  
11      estimate matrix element, an output of said second signal  
12      adder comprising said current inverse channel estimate  
13      matrix element.